(12) UK Patent Application (19) GB (11) 2 140 880 A

(43) Application published 5 Dec 1984

(21) Application No 8408850

(22) Date of filing 5 Apr 1984

(30) Priority data

(31) 58/058717	(32) 21 Apr 1983	(33) JP
58/148206	27 Sep 1983	
58/148207	27 Sep 1983	
58/165940	28 Oct 1983	

(51) INT CL^3
F16J 15/40

(52) Domestic classification
F2B 13B3A7A 13B3B1A 13B3D2C 13B3E2 13C10 13C14 13C2E3A 13C2X7
U1S 1785 2317 F2B

(56) Documents cited

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GB 1596546	GB 1212335
GB 1571342	GB 1170008
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(58) Field of search
F2B

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(54) Shaft sealer

(57) Disclosed is a propeller shaft seal device 1 wherein an annular case member comprising units 5, 6, 7, 8 is arranged on the outer periphery of a shaft 2, a plurality of seal members 12, 17, 20 are disposed in annular gaps formed between the shaft and the case member to form a multiple stage seal against sea water A and lubricating oil B, and pressure fluid is fed through line 27 into the seal portion so as to enhance the sealing effect by pressure of the fluid on seal member 12 and lip seal 17. Seal members 12 in Fig. 1 are segment seal members, but a hollow rubber ring could be used instead, Fig. 5 (not shown).

Several embodiments are described.

FIG.1

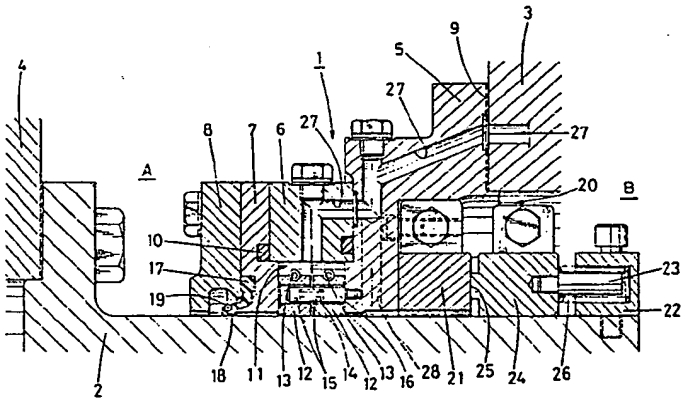

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FIG.1

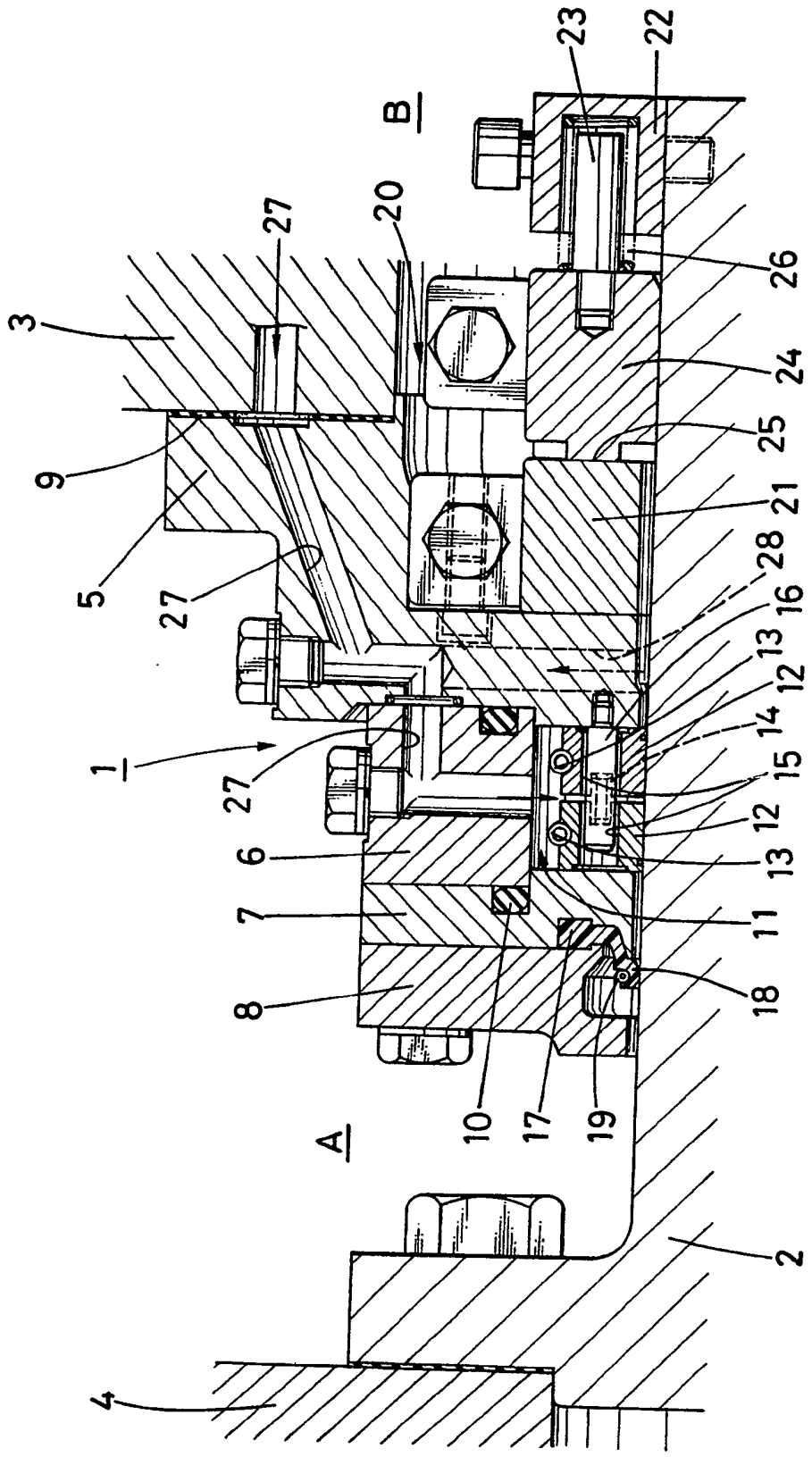
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FIG.2

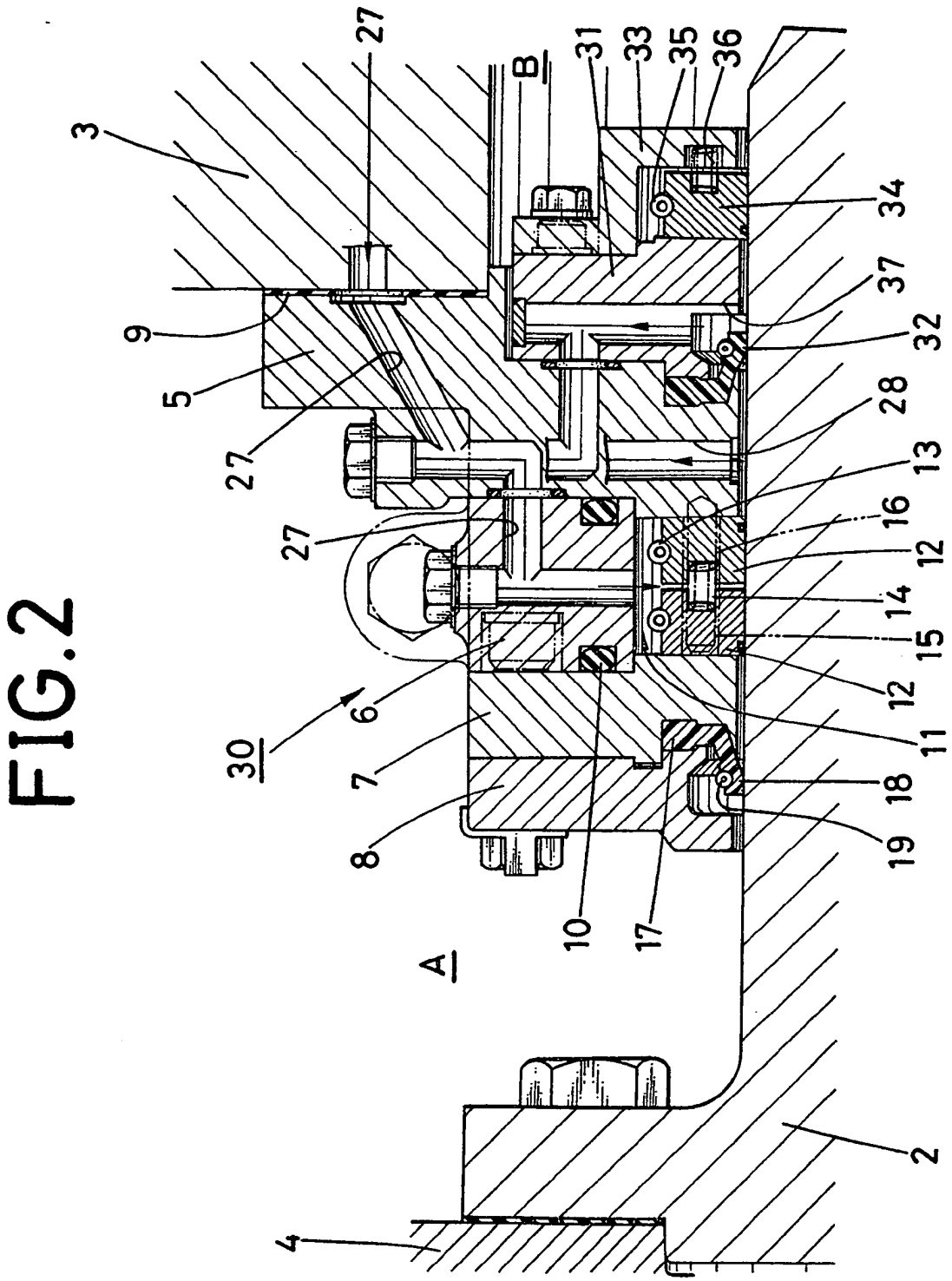
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FIG.3

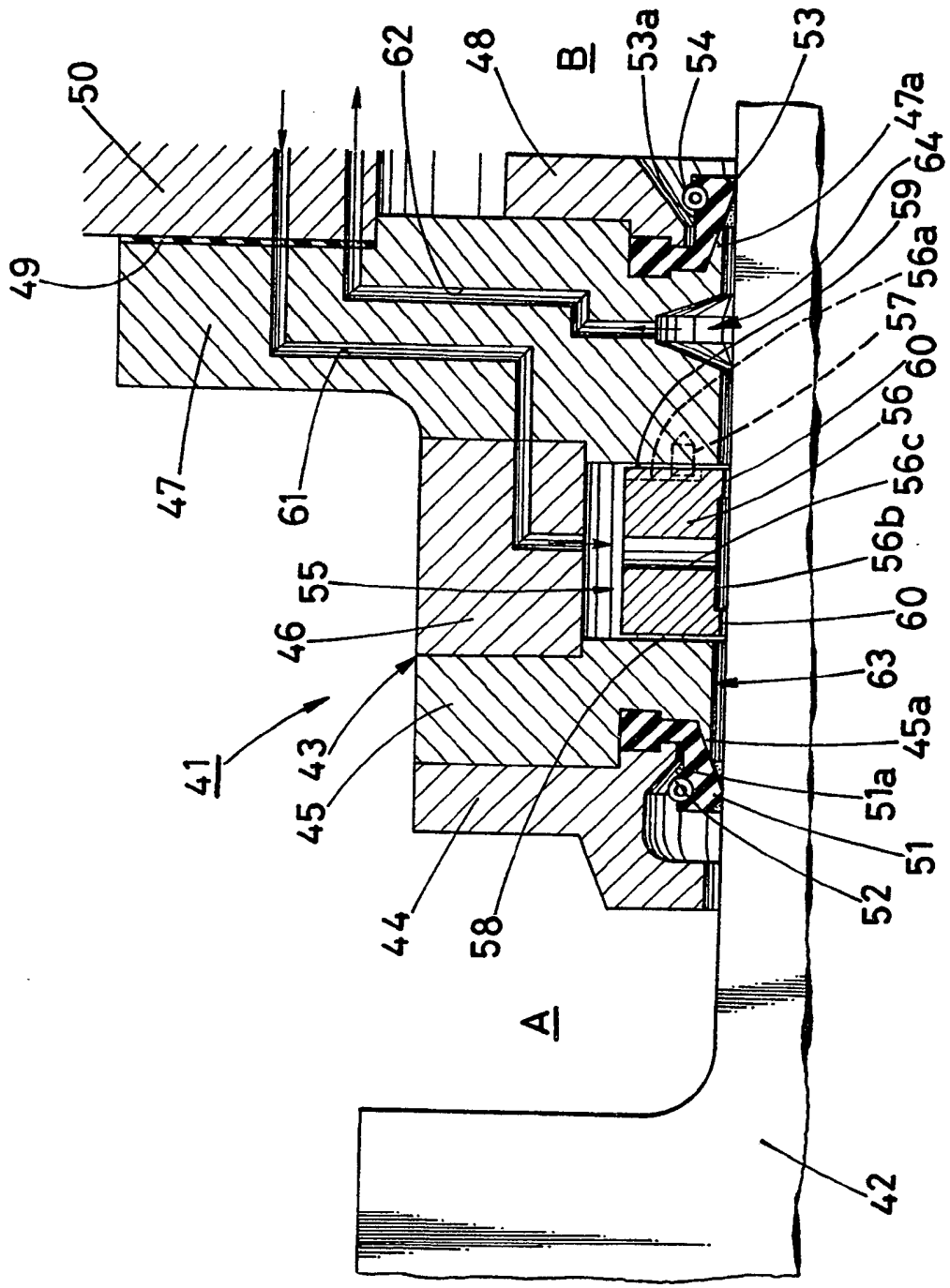

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FIG.4

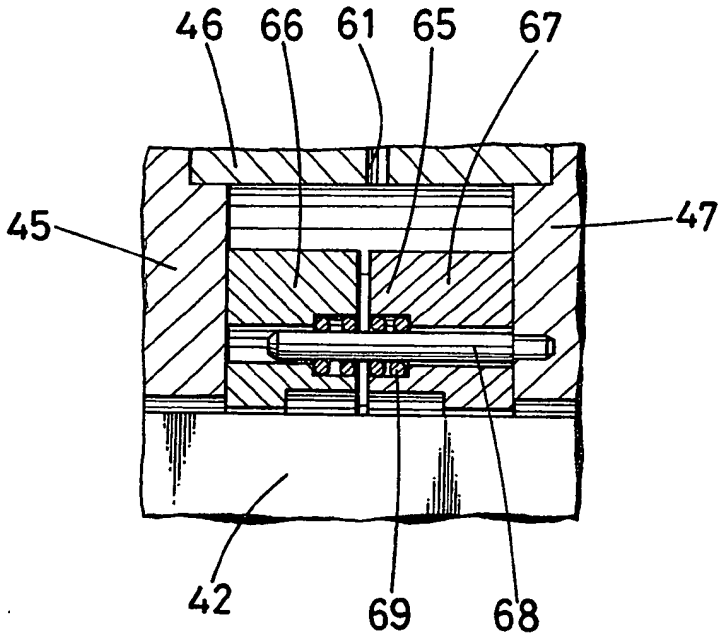

FIG.5

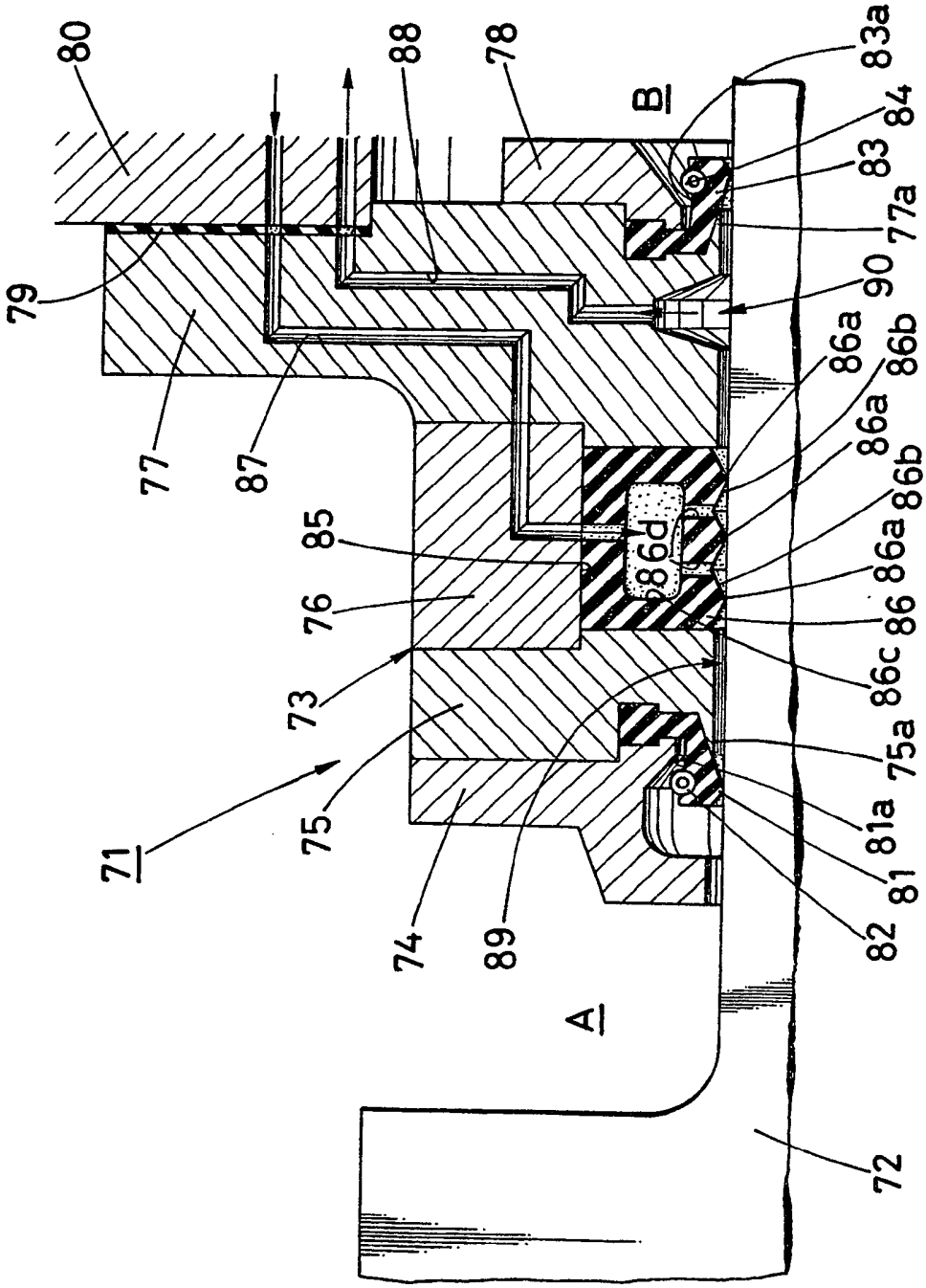
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FIG.6

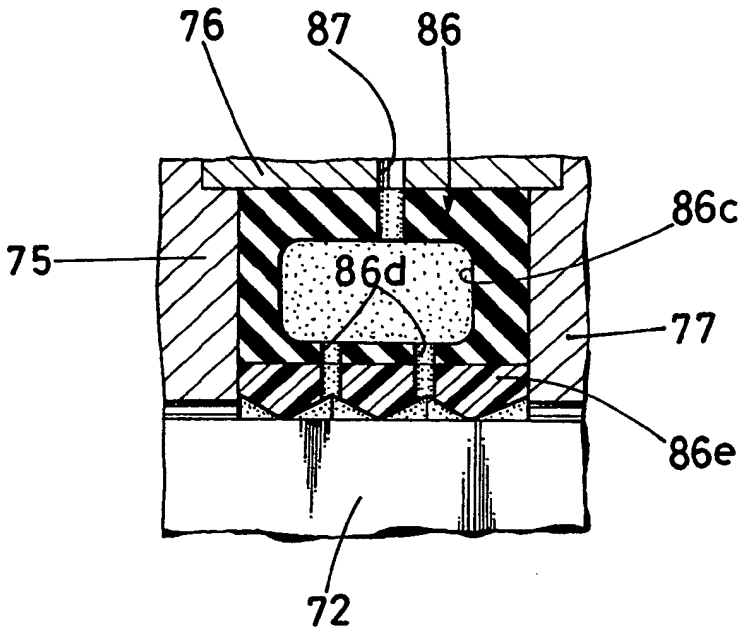

FIG.7

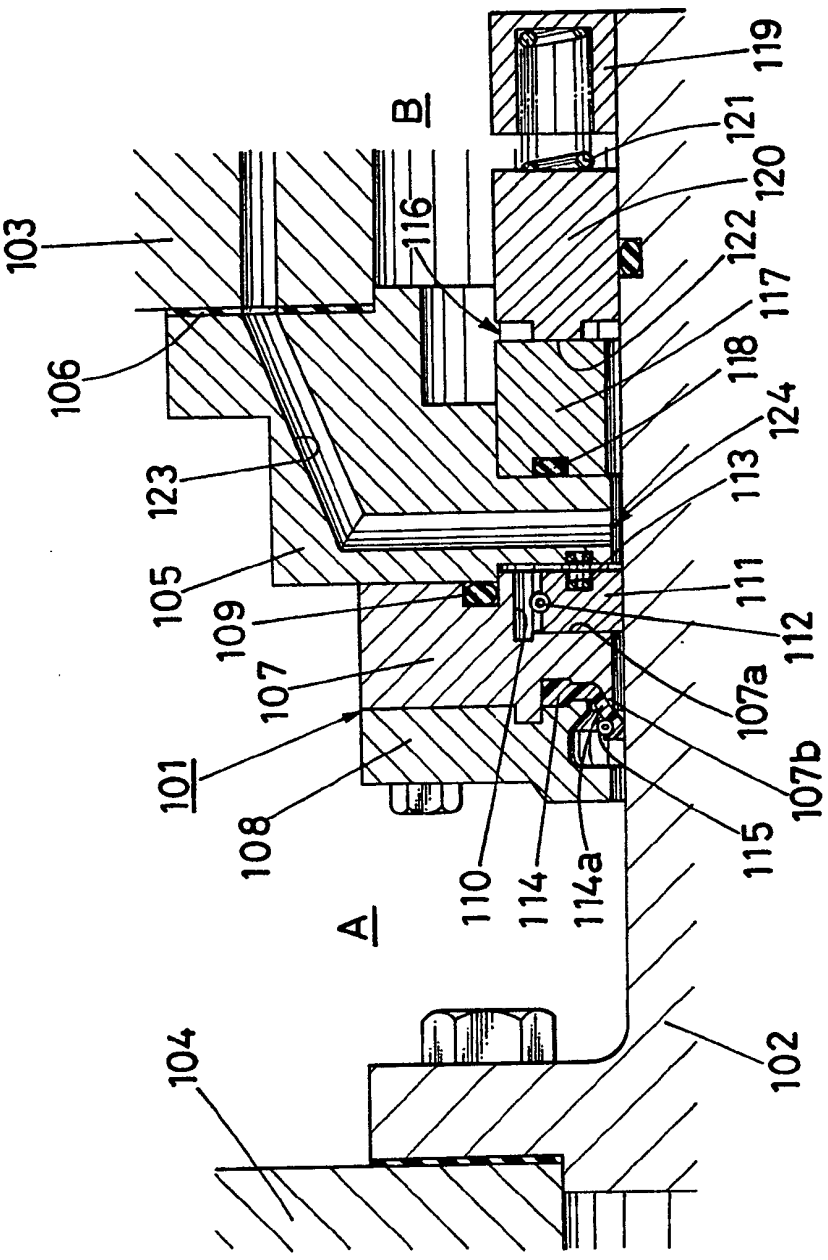
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FIG.8

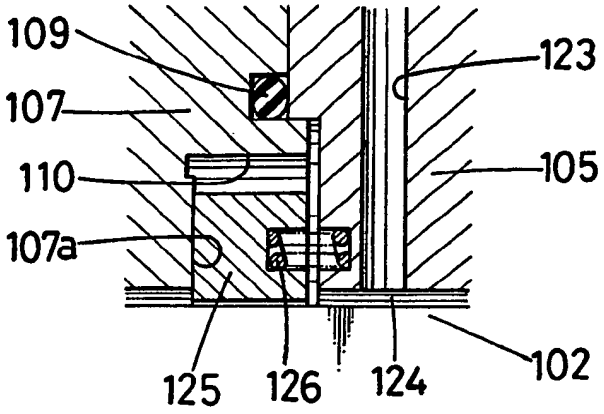


FIG.9

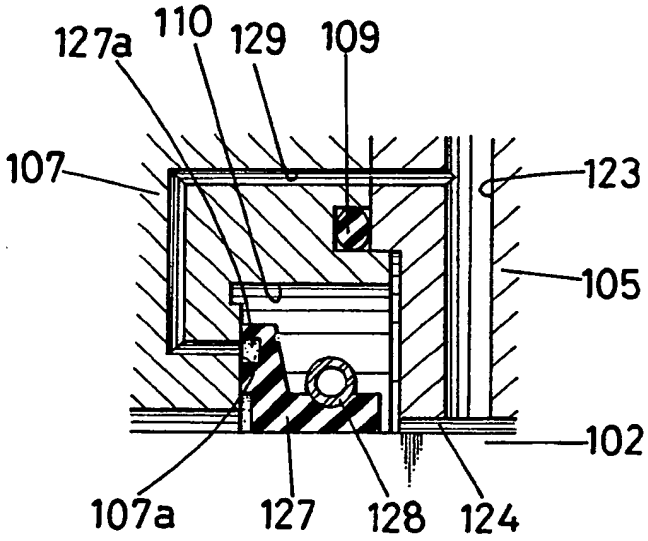
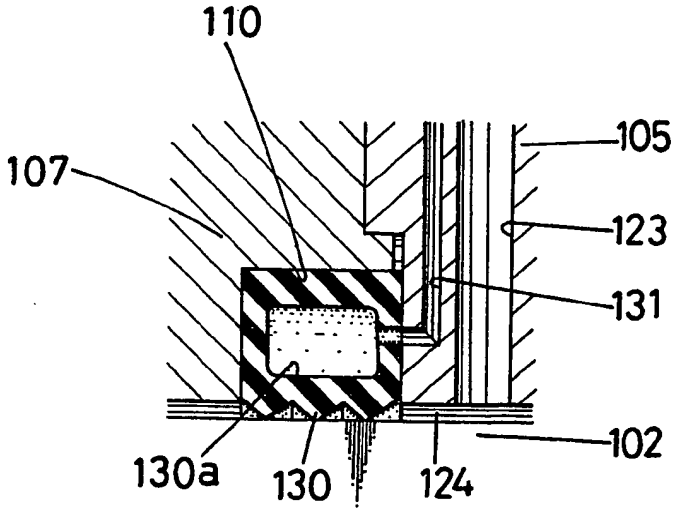


FIG.10



SPECIFICATION

Stern tube seal device

The present invention relates to a stern tube seal device.

One prior art seal device known heretofore has been designed so that a plurality of lip seals in close contact with and slidable relative to the shaft are arranged or mechanical seals are disposed so as to prevent both forms of leakage, one being leakage of sea water into a machine (into a ship) and the other being leakage of lubricating oil (bearing oil) to the outside of the ship. However, in these prior arrangements, the seal relies upon the sliding portion formed between the lip seal and the peripheral surface of the shaft or the sliding portion of the mechanical seal. If operation is carried out for a long period of time, the sliding portion tends to be worn or deformed to impair the performance of the seal, resulting in a danger of the lubricating oil flowing outside the ship to contaminate the sea.

In view of the problems noted above, it is an object of the present invention to provide a stern tube seal device which enhances the long-period durability of the device and provides an improved seal performance with respect to both sea water and lubricating oil and a slurry resisting performance while preventing the sea from being contaminated due to the leaking of lubricating oil outside the ship.

To achieve the above-described object, a stern tube seal device in accordance with the present invention is provided in which an annular case member is arranged on the outer periphery of a shaft, a plurality of seal members are disposed within an annular gap formed between the shaft and the case member to provide a multiple stage seal portion with respect to sea water and lubricating oil, and a pressure fluid line for feeding pressure fluid towards said seal portion is provided to enhance the sealing effect.

While the present invention has been briefly described, the present invention and other objects and novel features thereof will become completely apparent from reading of the following detailed description in connection with embodiments shown in the accompanying drawings. However, the drawings show the embodiments merely for the purpose of understanding the present invention and the scope of the present invention is not limited thereby. In the drawings:-

Figure 1 is a top half of a sectional view of a stern tube seal device in accordance with a first embodiment;

Figure 2 is a top half of a sectional view of a stern tube seal device in accordance with a second embodiment;

Figure 3 is a top half of a sectional view of a stern tube seal device in accordance with a third embodiment;

Figure 4 is a sectional view showing an essential part of a stern tube seal device in accordance with a forth embodiment;

Figure 5 is a top half of a sectional view of a stern tube seal device in accordance with a fifth embodiment;

Figure 6 is a sectional view showing an essential part of a stern tube seal device in accordance with a sixth embodiment;

Figure 7 is a top half of a sectional view of a stern tube seal device in accordance with a seventh embodiment; and

Figures 8 through *10* are respectively sectional views showing an essential part of a stern tube seal device in accordance with other embodiments.

First, a stern tube seal device in accordance with a first embodiment of the present invention will now be described with reference to Figure 1.

The stern tube seal device generally indicated at 1 seals between a shaft or a sleeve 2 fitted externally of the shaft and a ship's hull 3 in which the shaft is mounted. A reference numeral 4 designates a part of a propeller mounted on the extreme end of the shaft.

A reference numeral 5 designates a first case member (casing) fixed to the ship's hull 3 through a gasket 9, while a second case member (an intermediate ring 6), a third case member (an adapter ring 7) and a fourth case member (an aft cover 8) are airtightly mounted in that order from the first case member 5 towards sea water A by the use of packings 10 or the like. In these case members 5, 6, 7 and 8 which are annular in shape, only the second case member 6 has a large diameter hole, said second case member 6 having and annular recess portion 11 formed in the inner periphery thereof, said annular recess portion 11 having a pair of segment seal members 12 and 12 disposed therein. The segment seal members 12 and 12 are brought into close contact with the outer peripheral surface of the sleeve 2 by fastening forces of garter springs 13 and 13. The segment seal member 12 at the left side in the Figure is brought into close contact with the end of the third case member 7 by the compressive force of a coiled spring 14 which resiliently acts between the members 12 and 12 so that the segment seal member 12 at the right side is brought into close contact with the end of the first case member 5. A pin 16 fixed to the first case member 5 is fitted into holes 15 and 15 coaxially bored in both the members 12 and 12 to stop rotation of the segment seal members 12 and 12 with respect to the case member 5.

A reference numeral 17 designates a lip seal member held and secured between the third and fourth case members 7 and 8, an an annular lip 18 having a garter spring 19 fastened thereto is brought into close contact with the outer peripheral surface of the sleeve 2 against sea water A. A reference numeral 20 designates a mechanical seal disposed between a source of lubricating oil B and the segment seal members 12 and 12, which mechanical seal comprises a ring 21 fixed in the inner periphery of a shoulder of the first case member 5 and a sliding ring 24 fixed by a pin 23 with respect to a cover ring 22 fixed to the sleeve 2. The ring 24 therefore rotates with the sleeve 2 while providing a sliding surface 25 in sealing contact with the ring 21. The sliding ring 24 is resiliently biased towards the ring 21 by means of a coiled spring 26. A reference numeral 27 designates a pressure gas feeding system from the ship's hull 3 in communication with the interior of

the annular recess portion 11 closed by the segment seal members 12 and 12. This provides a pipe line which extends through the first and second case members 5 and 6 from the ship's hull 3, and pressure gas is fed into the annular recess portion 11 by a feeding device (not shown) disposed in the pipe line. A reference numeral 28 designates a leaked liquid recovery system formed separately from the pressure gas feeding system 27, which is open to a space between the right hand segment seal member 12 and the mechanical seal 20 to recover the leaked liquid entering this space.

As described above, the stem tube seal device 1 constructed as described above is to prevent leaking of sea water A into the ship and leaking of lubricating oil B outside the ship. In general, the pressure gas feeding system 27 and leaked liquid recovery system 28 are placed in operation during sealing. On the other hand, the lip seal member 17 and lefthand segment seal member 12 serve to prevent sea water A from leaking-in. In particular, the segment seal member 12 is subjected to pressure gas fed into the annular recess portion 11 and strongly pressed against the sleeve 2 and case member 7 to enhance the sealing effect. In addition, when the pressure of the pressure gas is increased, the pressure gas passes through the seal and is present in the space between the lip seal member 17 and the left hand seal member 12 so that it is balanced by sea water pressure in said space so acting as a seal. Furthermore, when the space is filled with pressure gas, back pressure is applied to the lip seal member 17 to place the lip seal member 17 in an idling state (the force holding it in close contact with the sleeve 2 disappears) to prevent early wear, deformation or the like of the member 17. In this case, the lip seal member 17 acts as a dust seal which prevents entry of foreign matter into the ship, but when the pressure of pressure gas decreases, the lip seal member 17 is pressed by sea water pressure into close contact with the sleeve 2 to act automatically as a first sea water resisting seal. Referring now to the lubricating oil B, the mechanical seal 20 acts as a first seal portion to prevent it from leaking, and even if the lubricating oil B should leak through the seal portion, leaking of the oil outside the ship can be completely cut off by the right hand segment seal 12. If the lubricating oil B enters the space between the mechanical seal 20 and the segment seal portion 12, the oil passes through the seal portion of the segment seal member 12 and is recovered together with pressure gas escaping by way of the space between the mechanical seal 20 and segment seal portion 12 by the leaked oil recovery system 28 and passes into the ship for reuse. The stern tube seal device constructed as described above can completely seal both sea water A and lubricating oil B in a manner as described above,

Next, a second embodiment of the present invention will be described with reference to Figure 2. In Figure 2, the same reference numerals as those used in the above-described first embodiment (Figure 1) designate the same members. That is, a reference numeral 2 designates a sleeve, 3 a ship's hull, 4 a propeller, 5, 6, 7 and 8 case members, 11 an annular recess portion, 12 and 12 segment seal members, 17 a lip seal member, 27 a pressure gas feeding system, and 28 a leaked oil recovery system

A stern tube seal device 30 having these members is principally different from the device shown in the above-described first embodiment in the following. That is, a fifth case member 31 is fitted in the inner periphery of a shoulder of the first case member 5, and a second lip seal member 32 is held and secured between the members 5 and 31. A sixth case member 33 is further fitted at the side of the fifth case member 31, that faces the container for lubricating oil B and a third segment seal member 34 is mounted as a float seal member in a space between the members 31 and 33. The segment seal member 34 is brought into close contact with the outer peripheral surface of the sleeve 2 by a garter spring 35 fitted in the outer periphery of the segment seal member. The segment seal member 34 is brought into close contact with the end of the fifth case member 31 by a coiled spring 36 fixed by a pin (not shown) with respect to the sixth case member 33. A pipe line of a second leaked liquid recovery system 37, which is open to a space between the lip seal member 32 and segment seal member 34, is provided extending from the fifth case member 31 to the first case member 5. The first and second leaked liquid recovery systems 28 and 37 comprise joined pipe lines within the first case member 5 or ship's hull 3 for common use by an intake recovery device such as a pump.

The stern tube seal device 30 constructed as described above operates as a water A resisting seal in the same way as the above-described first embodiment. As for the lubricating oil B, the first seal portion is formed by the third segment seal member 34 and reduces leakage to an extremely reduced state when lubricating oil leaks through the seal portion, and therefore, sufficient sealing can be achieved by the lip seal member 32 without much difficulty to recover the leaked oil into the ship by the leaked liquid recovery system 37.

Next, a third embodiment will be described with reference to Figure 3.

In this Figure, a reference numeral 42 designates a shaft (including a sleeve fitted externally on the shaft) to the left-hand of which is mounted a propellor (not shown). A composite case member 43 comprising first to fifth members 44, 45, 46, 47 and 48 is arranged round the outer periphery of the shaft 42 and fixed to a ship's hull 50 through a packing 49. A reference numeral 51 designates an outer lip seal which is located in the inner periphery of a hole of the case member 43 and held between the first case member 44 and the second case member 45, the outer lip seal having a pressure receiving surface 51a, which is fitted with a fastening ring 52, arranged opposite sea water A. A back-up ring portion 45a for controlling operation of the lip seal 51 is provided at the rear of the second case member 45 in contact with the lip seal 51. A reference numeral 53 designates an inner lip seal held between the fourth case member 47 and the fifth case member 48, the inner lip seal having a pressure receiving surface 53a, which is fitted with a fastening ring 54, directed

towards a container for lubricating oil B. A back-up ring portion 47a with respect to the lip seal 53 is provided in the inner periphery of the fourth case member 47. The inside diameter of the third case member 46 is made greater than that of other four members 44, 45, 47 and 48, particularly the second and fourth case members 45 and 47, and an annular recess portion 55 is formed in the inner periphery of the third case member 46, the annular recess portion 55 being provided therein with a floating ring seal 56. This floating ring seal 56 is such that a pin 57 projecting from the fourth case member 47 engages a groove 56a formed in one end of the ring seal 56. The ring seal 56 is, therefore, stationary with respect to the composite case member 43 and both ends and an inner peripheral surface of the ring seal 56 are slightly spaced from the ends of the second and fourth case members 45 and 47 and from the peripheral surface of the shaft 42 to form fine clearances 58, 59 and 60. The floating ring seal 56 is formed in its inner peripheral surface with an annular groove 56b and is provided with a number of through-holes 56c which extend through its inner and outer peripheral surfaces. A reference numeral 61 designates a feed line for pressure fluid in communication with the annular recess portion 55 and extending from the interior of the ship's hull. The feed line 61 extends through the third and fourth case members 46 and 47 to feed pressure fluid into the annular recess portion 55 from a fluid feed device (not shown) disposed within the ship. A reference numeral 62 designates a leaked liquid recovery line formed separately from the pressure fluid feed line 61, which recovery line is open to a space between the floating ring seal 56 and the internal lip seal 53 to recover leaked liquid that has entered the space and deliver it into the ship by means of a pump or the like (not shown).

In the stern tube seal device 41 constructed as described above, when pressure fluid is fed into the annular recess portion 55 from the pressure fluid feed line 61, the annular recess portion 55 and annular groove 56b of the floating ring seal 56 in communication with the recess portion 55 through the through-hole 56c are filled with pressure fluid, and the pressure fluid passes through the clearances 58, 59 and 60 and gradually flows into spaces 63 and 64. The part of this pressure fluid that flows into the space 63 between the external lip seal 51 and floating ring seal 56 is stored in the space 63 so as to provide back pressure with respect to the external lip seal 51 and lower a pressure between the lip seal 51 and the peripheral surface of the shaft 42 and to prevent entry of sea water. In this case, it is considered that the pressure fluid might flow out of the ship depending on its pressure, and therefore, it is desirable to select and use pressure fluid which poses no problem in terms of contamination of the sea, and preferably, the pressure fluid is air or another gas. On the other hand, pressure fluid that flows into the space between the internal lip seal 53 and the floating ring seal 56 is recovered into the ship from the leaked liquid recovery line 62 together with lubricating oil B leaked through the internal lip seal 53, if any. In this manner, the floating ring seal 56 can sufficiently perform a function as a secondary seal with respect to the lip seals 51 and 53 so far as the pressure fluid is concerned. Even if feeding the pressure fluid is stopped for some reason, the floating ring seal 56 functions as a secondary seal of a limited leaking type to maintain the sealing effect to some extent in cooperation with the recovery system through the leaked liquid recovery line 62. Accordingly, in accordance with the seal device 41 constructed as described above, the external lip seal 51 is pressed at the forward surface by the pressure fluid to lower the pressure between the lip seal 51 and the peripheral surface of the shaft 42 to enhance the durability of the lip seal 51, which can otherwise become worn materially positively to seal both sea water A and lubricating oil B and to recover the lubricating oil B into the ship through the leaked liquid recovery line 62, thus removing fear of contaminating the sea.

Next, Figure 4 shows an essential part of a fourth embodiment. That is, that the floating ring seal 56 comprises a double type seal 65 whose rear surfaces are opposed. Both seal members 66 and 67 are held against rotation by a common pin 68, and the required number of springs 69 are interposed between both the seal members 66 and 67.

Next, a fifth embodiment of the present invention will be described with reference to Figure 5. In this Figure, a reference numeral 72 designates a shaft (including a sleeve mounted externally on the shaft) to the left-hand of which is mounted a propeller (not shown). A case member 73 comprising first to fifth members 74, 75, 76, 77 and 78 is arranged on the outer periphery of the shaft 72 and fixed to a ship's hull 80 through a packing 79. A reference numeral 81 designates an outer lip seal which is located in the inner periphery of the hole of the case member 73 and held between the first case member 74 and the second case member 75, the outer lip seal having a pressure receiving surface 81a, which is fitted with a fastening ring 82 exposed to the sea water A. A back-up ring portion 75a for controlling the operation of the lip seal 81 is provided at the rear of the second case member 75 in contact with the lip seal 81. A reference numeral 83 designates an inner lip seal held between the fourth case member 77 and the fifth case member 78, the inner lip seal having a pressure receiving surface 83a, which is fitted with a fastening ring 84, directed towards lubricating oil B to which the outer lip seal 81 is opposed. A back-up ring portion 77a in contact with the lip seal 83 is provided on the inner periphery of the fourth case member 77. The inside diameter of the third case member 76 is made greater than that of the four members 74, 75, 77 and 78, particularly the second and fourth case members 75 and 77, and an annular recess portion 85 is formed in the inner periphery of the third case member 76. A reference numeral 86 designates a pressure type hollow ring made of rubber fitted into the annular recess portion 85, the hollow ring having a plurality (three shown in the Figure) of annular crest portions 86a provided in the inner peripheral surface thereof. Said crest portions 86a serve as a seal portion in contact with the shaft 72, and have the required number (two shown in the

Figure) of fine holes 86d bored to provide communication between a trough portion 86b, between the crest portions 86a, and a hollow portion 86c. A reference numeral 87 designates a pressure fluid feed line extending from the ship's hull towards the hollow portion 86c of the hollow ring 86 to feed pressure fluid into the hollow portion 86c from a fluid inlet device (not shown) disposed within the ship. A reference numeral 88 designates a leaked liquid recovery line formed separately from the pressure fluid feed line 87, which recovery line is open to a space between the pressure type hollow ring 86 and the inner lip seal 83 to recover leaked liquid that has entered the space and feed it into the ship by means of a pump or the like (not shown).

In the stern tube seal device 71 constructed as described above, when pressure fluid is fed into the hollow portion 86c of the pressure type hollow ring 86 from the pressure fluid feed line 87, the pressure fluid fills the hollow portion 86c, passes through the fine holes 86d and flows into a space of triangular section defined by inclined surfaces of the adjacent two crest portions 86a and the peripheral surface of the shaft 72 whereby pressure is balanced by the space and hollow portion 86c to bring the pressure type hollow ring 86 into contact with the shaft 72 under low load. When more pressure fluid is fed into the hollow ring 86, the pressure fluid breaks a seal between the pressure type hollow ring 86 and the shaft 72 and flows into spaces 89 and 90. Pressure fluid that flows into the space 89 between the outer lip seal 81 and the pressure type hollow ring 86 is stored in the space 89 to provide back pressure with respect to the outer lip seal 81, thus lowering the pressure between the lip seal 81 and the peripheral surface of the shaft 72 and preventing entry of sea water A. In this case, it is considered that the pressure fluid might spread the lip seal 81 and flow outside the ship depending on the pressure, and therefore, it is desirable to select and use a pressure fluid which poses no problem in terms of contamination of the sea, for example, the pressure fluid may be compressed air. On the other hand, pressure fluid that flows into the space 90 between the internal lip seal 83 and the pressure type hollow ring 86 is recovered and fed into the ship through the leaked liquid recovery line 88 together with any lubricating oil B that has leaked through the internal lip seal 83. In this manner, the pressure type hollow ring 86 can sufficiently perform a function as a secondary seal with respect to the lip seals 81 and 83 as far as the pressure fluid is concerned. Even if the feeding of pressure fluid is stopped for some reason, the hollow ring functions as a secondary seal of a limited leaking type to maintain the sealing effect to some extent in cooperation with the functioning of the leaked liquid recovery line 88. Accordingly, in accordance with the seal device 71 constructed as described above, the external lip seal 81 is pressed at its forward surface by the pressure fluid to lower the pressure between the lip seal 81 and the peripheral surface of the shaft 72 to enhance the durability of the lip seal 81. The lip seals to positively seal both sea water A and lubricating oil B and enable the lubricating oil B to be returned into the ship through the leaked liquid recovery line 88, thus removing fear of contamination of the sea.

Next, Figure 6 shows an essential part of a sixth embodiment. That is, the inner peripheral portion 86e of the pressure type hollow ring 86 is formed of synthetic rubber or fluoro-resin which is excellent in wear resistance to enhance the wear resistance.

Next, a seventh embodiment of the present invention will be described with reference to Figure 7. In Figure 7, the stern tube seal device generally indicated at 101 is mounted at the end of an opening of a ship's hull 103 so as to seal between a sleeve 102 fitted externally of a shaft (not shown) and a ship's hull 103 in which the shaft is mounted. A reference numeral 104 designates a part of a propeller mounted on the extreme end of the shaft. In the stern tube seal device 101, a reference numeral 105 designates a first casing fixed to the end of the ship's hull 103 through a gasket 106, and on the sea water side of the first casing 105, a second casing (adapter ring) 107 and a third casing (aft cover) 108 are airtightly fixed together by O-rings 109. In the inner peripheral of the surface of the second casing 107, an annular recess portion 110 is formed by the second casing 107 and the first casing 105 on the hole side of the casing 107, the annular recess portion 110 having a segment seal 111 mounted therein as a limited leaking type seal. This segment seal 111, which is circumferentially divided into more than one portion, is fastened by a garter spring 112 fitted on the outer periphery thereof and is in sliding close contact with the peripheral surface of the sleeve 102 and brought into close contact with a wall surface 107a of the second casing 107 by a coiled spring 113. The divided elements of the segment seal 111 are held against rotation with respect to the casings 105 and 107 by means of pins (not shown) projecting from the first or second casings 105, 107. A reference numeral 14 designates a lip seal held and secured between the second and third casings 107 and 108, the lip seal having a pressure receiving surface 114a fastened by a garter spring 115 exposed to sea water and holding the seal in close contact with the outer periphery of the sleeve 102. A back-up ring portion 107b for controlling excessive deformation of the lip seal 114 is provided on the second casing 107 in front of the lip seal 114. A reference numeral 116 designates a mechanical seal arranged at a position closer to a container for lubricating oil B in the inner periphery of a hole of the first casing 105, which seal is fitted in a shoulder of the first casing 105 and maintained airtight by an O-ring 118. The mechanical seal comprises a ring 117 at the fixed side of the mechanical seal and prevented from rotation with respect to the casing 105 by means of a pin (not shown), a cover ring 119 fixed to the sleeve 102 by means of a pin (not shown) and a sliding ring 120 at the rotational side of the mechanical seal held for rotation with the shaft by means of a pin (not shown). The sliding ring 120 at the rotational side is pressed by a coiled spring 121 to form a sealed sliding surface 122 in contact with the fixed ring 117. A reference numeral 113 designates a pressure fluid feed line for feeding pressure fluid from the side of

the ship's hull 103 towards an annular space 124 formed between the segment seal 111 and the mechanical seal 116. The feed line leads to this space through the first casing 105 from the ship's hull 103. A pressure fluid feed device (not shown) is provided within the ship's hull 103.

The stern tube seal device 101 constructed as described above is designed to prevent entry of sea water and slurry contained in sea water into the mechanical seal 116 by means of the lip seal 114 arranged externally of the mechanical seal 116 (on the sea water side), the segment seal 111 and the pressure fluid. It is noted that during sealing, as a rule, the feed device is actuated to feed pressure fluid. That is, first, the lip seal 114 and segment seal 111 serve to prevent entry of sea water A. In particular, the segment seal 111 is pressed against the peripheral surface of the sleeve 102 and the wall surface 107a of the second casing 107 to enhance the sealing effect. When the pressure of pressure fluid exceeds a certain level with respect to the segment seal 111 which is of a limited leaking type, the pressure fluid flows towards the lip seal 114 but the pressure fluid is balanced by the sea water pressure to exhibit the sealing effect. When the space between the lip seal 114 and segment seal 111 is filled with pressure fluid, back pressure is applied to the lip seal 114 by the pressure fluid to place the lip seal 114 in an idling state balanced by sea water pressure thereby preventing early wear, deformation or the like due to the sliding contact between the lip seal 114 and sleeve 102. The lip seal 114 also acts as a dust seal which prevents entry of foreign matter into the ship, but when the pressure of the pressure fluid decreases for any reason, the lip seal is pressed by sea water pressure into close contact with the sleeve 102 automatically to act as a first seal resisting the entry of sea water. It is noted that the pressure fluid might spread the lip seal 114 depending on the pressure involved and flow outside the ship, and therefore, air, nitrogen gas, clean water or the like which involves no problem such as public hazards, even if the fluid leaks into sea water, are desirable for use. On the other hand, lubricating oil B can be completely sealed by the mechanical seal 116, which has durable sealing properties.

Next, Figures 8 to 10 show modified embodiments of the present invention in which in place of a segment seal of a limited leaking type seal described in the previous embodiment, an integral type (which is not divided peripherally) floating ring seal 125 (Figure 8), an end type rubber seal 127 (Figure 9) or a hollow type pressure ring 130 (Figure 10) is used. The floating ring seal 125 shown in Figure 8 is prevented from rotation by means of a pin (not shown) mounted on the first or second casings 105, 107 and pressed by a coiled spring 126 in contact with the wall surface 107a of the second casing 107 and has a fine clearance relative to the peripheral surface of the sleeve 102 to seal pressure fluid in the manner of a limited leaking type seal. The end type rubber seal 127 shown in Figure 9 is pressed over the sleeve 102 by a garter spring 128 to form a sealed sliding surface relative to the wall surface 107a of the second casing 107. A flushing line 129 through said second casing 107 is open to an annular groove 127a formed in said surface 107a. This flushing line is branched from the pressure fluid feed line 123, and clean water is used as a feed fluid to thereby provide lubrication for the sliding surface. The hollow type pressure ring 130 shown in Figure 10 is mounted in close contact with the first and second casings 105 and 107 and fills the annular recess portion 110. The hollow ring 130 communicates with the pressure fluid feed line 123 which feeds the hollow 130a in the ring. Alternatively, pressure air is fed separately from a line 131 into the ring so that it is expanded from inside to come into close sliding contact with the peripheral surface of the sleeve 102. Use of the pressure type hollow ring 130 enables the state of close contact with the peripheral surface of the sleeve 102 to be varied by controlling the pressure air to compensate for the amount of pressure fluid leaking. An inner peripheral surface portion of the hollow ring 130, which is normally formed of synthetic rubber or the like, can be formed of a sliding material such as fluororesin to thereby enhance the wear resistance.

In the stern tube seal device of the present invention, generally, a segment seal member, a lip seal member, a mechanical seal and the like constitute a multiple stage seal portion, and pressure of pressure fluid is utilized, as described above. Therefore, not only excellent sealing performance with respect to both sea water and lubricating oil is displayed, but also the load on the lip seal arranged closer to sea water can be relieved by the pressure of pressure fluid to prevent wear. Moreover, damage to the mechanical seal is prevented, thus enhancing the long-period durability of the whole device. In addition, contamination of the sea can be prevented effectively to cope with various problems of contamination which have been recently raised as an international problem.

While the preferred embodiments of the present invention have been described, it will be apparent that the present invention can be variously modified without departing from the principle thereof. It is therefore desired that all the modifications, by which the effects of the present invention are obtained substantially through the use of substantially identical or corresponding structures, are included in the present invention as defined by the appended claims.

CLAIMS

1. A stern tube seal device in which an annular case member is arranged on the outer periphery of a shaft, a plurality of seal members are disposed within an annular gap formed between said shaft and said case member to provide a multiple stage seal portion with respect to sea water and lubricating oil, and a pressure fluid feed line for feeding pressure fluid towards said seal portion is provided for the purpose of enhancing the sealing effect.

2. The stern tube seal device according to Claim 1, wherein an annular recess is provided in the inner peripheral surface of the passage through said annular case member, said annular recess having a

segment seal member disposed therein, a feed system including said fluid feed line being arranged for feeding pressure gas to said annular recess, said recess being closed by said segment seal member and a lip seal member being arranged at the sea water side of said segment seal member whereas a mechanical seal, packings or other floating seal member is arranged at the lubricating oil side thereof.

3. The stern tube seal device according to Claim 1, wherein a mechanical seal providing a seal between said case member and the peripheral surface of the shaft is disposed at a position comparatively close to the ship on the inner periphery of said case member, an annular recess is formed on the side of said mechanical seal remote from the ship in the inner peripheral surface of said casing member and a limited leaking type seal in sliding contact with the peripheral surface of the shaft is fitted in said annular recess, said pressure fluid feed line being open to an annular space between said limited leaking type seal and said mechanical seal to feed pressure fluid thereto.

4. The stern tube seal device according to Claim 1, wherein a plurality of lip seals are fixed to the inner periphery of the passage through said case member, an annular recess is formed in the inner peripheral surface of said passage between two of said plurality of lip seals, said annular recess having a seal member disposed therein, said pressure fluid feed line being arranged for feeding pressure fluid towards said seal member.

5. The stern tube seal device according to Claim 4, wherein a floating ring seal is used as said seal member.

6. The stern tube seal device according to Claim 4, wherein said seal member is a pressure type hollow ring having a plurality of crest portions continuously extending round the inner peripheral surface thereof to form a seal portion, and holes providing communication between a hollow portion of said ring and at least one trough between said crest portions are formed in the ring.

7. A stern tube seal device substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

8. A stern tube seal device substantially as hereinbefore described with reference to Figure 2 of the accompanying drawings.

9. A stern tube seal device substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

10. A stern tube seal device substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

11. A stern tube seal device substantially as hereinbefore described with reference to Figure 5 of the accompanying drawings.

12. A stern tube seal device substantially as hereinbefore described with reference to Figure 6 of the accompanying drawings.

13. A stern tube seal device substantially as hereinbefore described with reference to Figure 7 of the accompanying drawings.

14. A stern tube seal device substantially as hereinbefore described with reference to Figure 8 of the accompanying drawings.

15. A stern tube seal device substantially as hereinbefore described with reference to Figure 9 of the accompanying drawings.

16. A stern tube seal device substantially as hereinbefore described with reference to Figure 10 of the accompanying drawings.

Printed in the UK for HMSO, D8818935, 10/84, 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.